April 17, 1956 J. K. HEYL ET AL 2,742,176

APPARATUS FOR SUB-ZERO TREATMENT OF METALS

Filed July 29, 1952 3 Sheets-Sheet 1

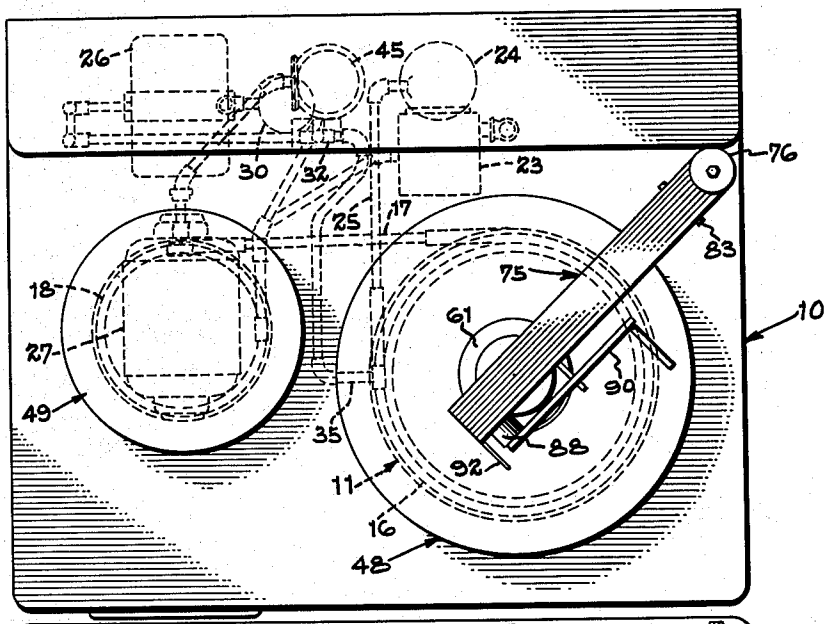


Fig. 1

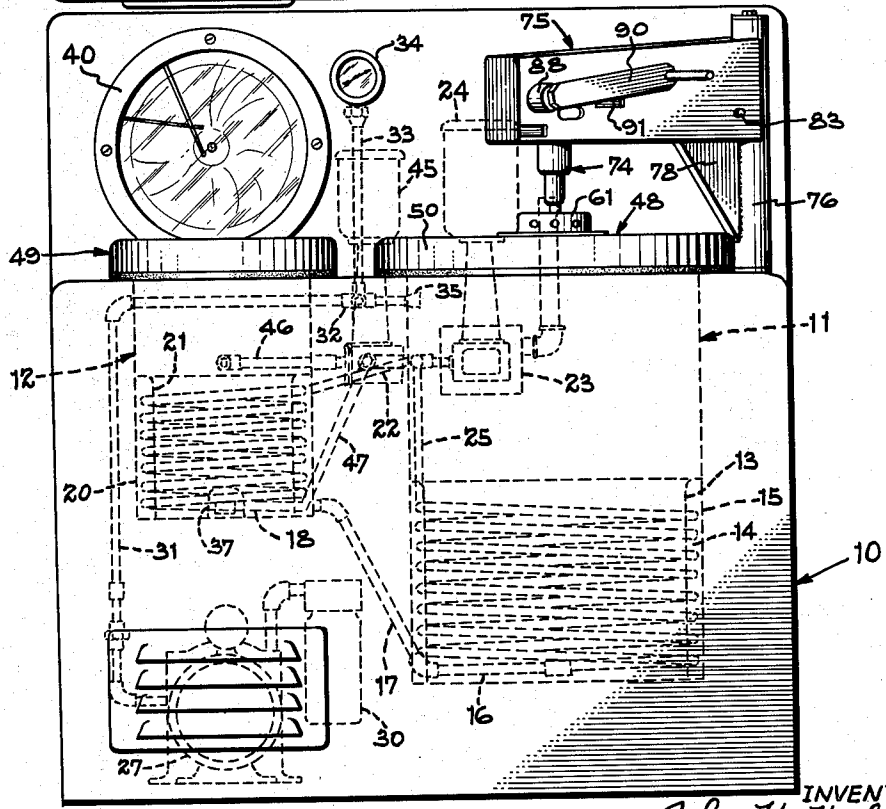


Fig. 2

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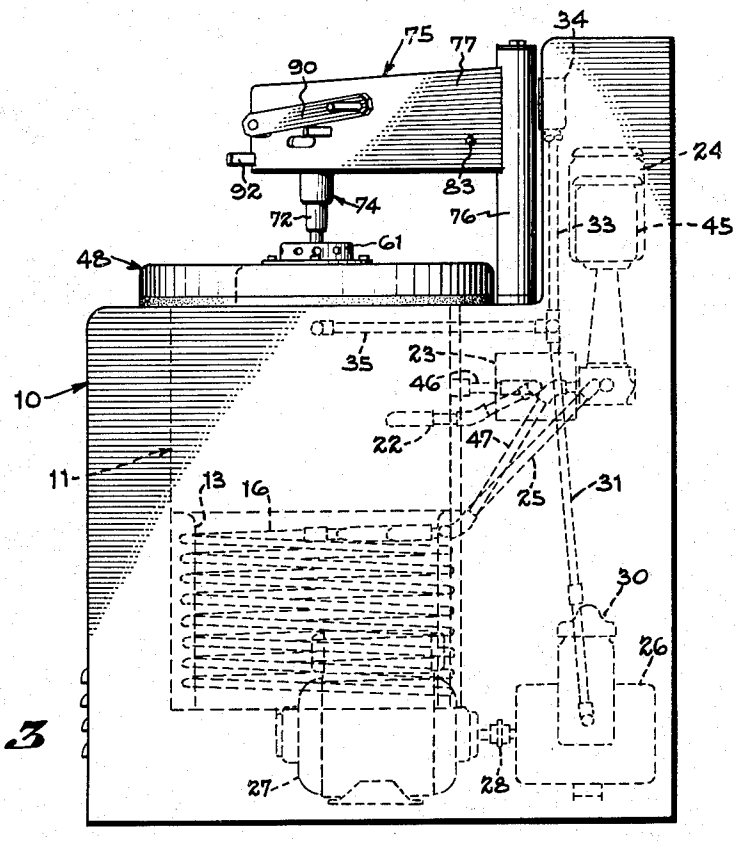


Fig. 3

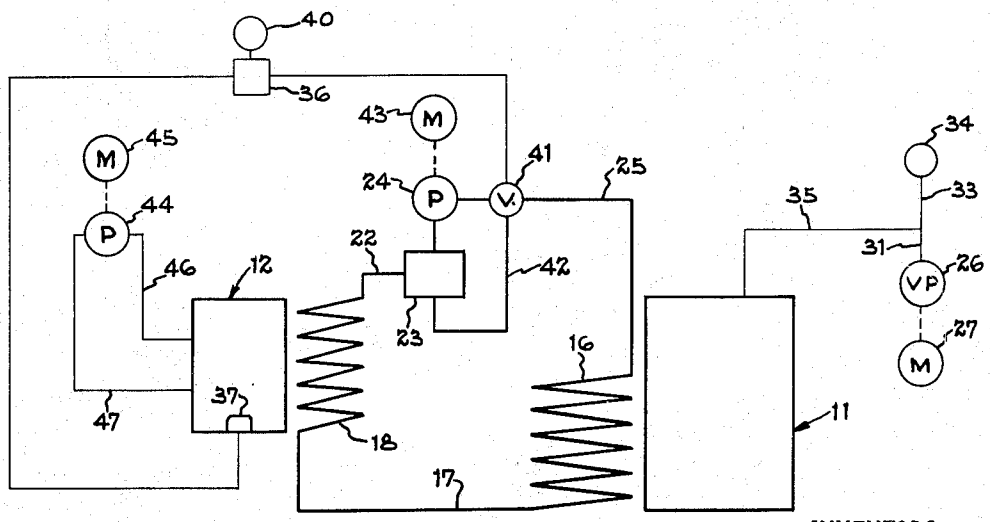


Fig. 8

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Filed July 29, 1952 3 Sheets-Sheet 3

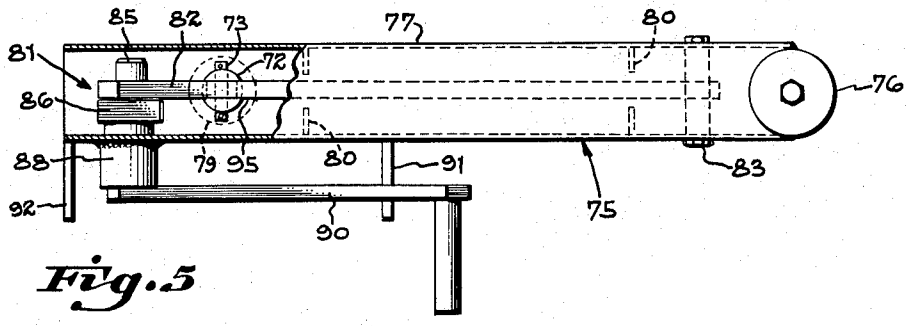


Fig. 5

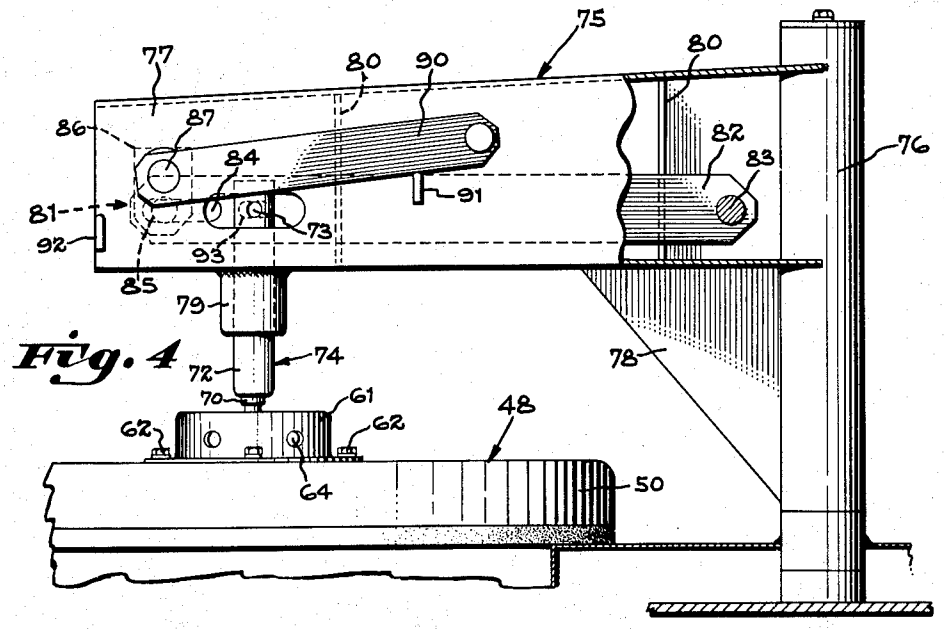


Fig. 4

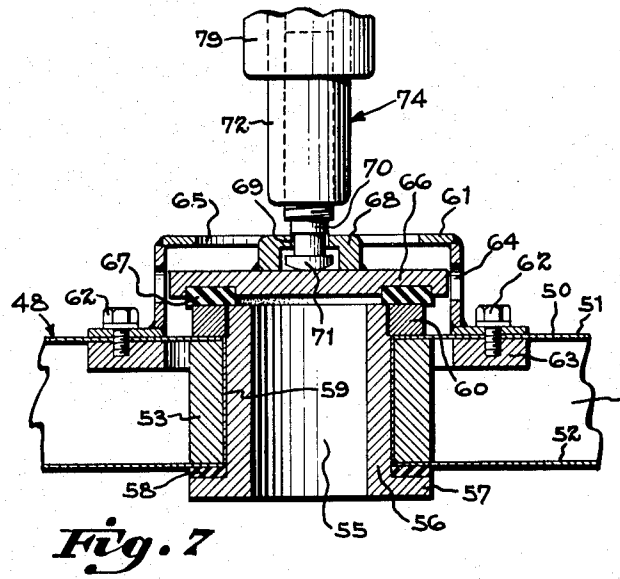


Fig. 7

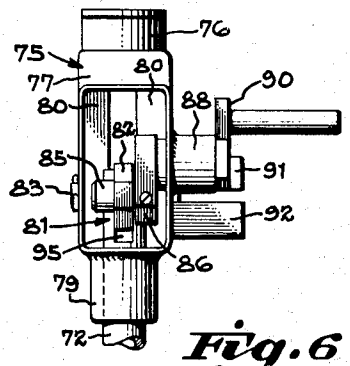


Fig. 6

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2,742,176

APPARATUS FOR SUB-ZERO TREATMENT OF METALS

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Application July 29, 1952, Serial No. 301,482

4 Claims. (Cl. 220—36)

This invention relates to a device for treating metals at sub-zero temperatures and is particularly directed to improvements upon apparatus of the type disclosed in Patent No. 2,445,294, issued to A. L. Nelson.

There are many instances where it has been found useful to treat metals at temperatures substantially below zero degrees Fahrenheit. For example, certain types of tool steels can be stress relieved at temperatures below minus 100° F. In fact, there are many different types of steels which exhibit extremely desirable metallurgical characteristics after they have been treated at reduced temperatures. Furthermore, it is often desirable to lower the temperature of metallic parts in order to shrink fit them. In such instances no metallurgical changes are sought, but rather two parts are firmly joined together by first thermally contracting one part and then allowing it to expand after it has been fitted together with its mating part. In other words, in a shrink fitting operation, one part which is to be fitted into or joined to another, is substantially chilled so that it contracts; and while this member is in the contracted stage, the second member, which has been allowed to remain at a higher temperature is placed over the first member. As the temperature of the chilled member rises, it expands and eventually reaches a size sufficient to prohibit disjointure of the assembled parts.

The present invention is concerned with devices for cooling metals in order to accomplish these and other operations. Devices of this general type depend, for their cooling action, upon the accelerated sublimation of Dry Ice which is submerged in an organic solvent such as methanol. These two substances stabilize at a temperature approximately 110° F. below zero, and as explained in the Nelson patent, by drawing a vacuum on the surrounding air their temperature may be stablized as low as —145° F. The methanol and Dry Ice are usually placed in a cooling chamber or vat and the metals to be treated are immersed in this methanol carbon dioxide bath.

One of the principal advantages of using what might be termed a "chemical" refrigerator, as compared to a conventional mechanical refrigerator is that of economy. A conventional mechanical refrigerator requires almost ten hours to reach working temperature from room temperature. Consequently, unless it is in continuous use, a mechanical refrigerator is extremely uneconomical to operate since over long periods of time it is running unproductively, merely in order to lower its own temperature. Furthermore, its initial cost is considerably higher than that of a chemical refrigerator.

In contrast, by using Dry Ice and methanol as a refrigerant, the temperature of a cooling chamber can be reduced from room temperature to an operating temperature of from —130° to —140° F. in three hours. The cooling device can thus be used only when it is actually needed, since it is unnecessary to have it in operation for long precooling periods. This is not only economical but also extremely convenient since the cooling apparatus can

be put into operation on short notice without the necessity of running it continuously.

There is one disadvantage of such a system, however, which it is the object of the present invention to eliminate. This disadvantage is the inherently limited range of temperature which can be maintained by means of a methanol Dry Ice cooling system. The equilibrium temperature of Dry Ice and methanol is in the vicinity of —112° F. at atmospheric pressure, and drops to minus 145° at 25 inches of vacuum. Thus the practical operating range of a chamber cooled by methanol and Dry Ice even with a variable vacuum pump system, would extend over only 35° F.

However, there are many metals which, if placed directly in a minus 140° F. bath, would be injured due to shock. In order to treat these metals it is necessary to lower their temperature gradually in some predetermined manner. Furthermore, there are other metals at which optimum metallurgical properties can be reached by subjecting them to less severe temperatures of the order of —40° or —50° F. for example. This higher temperature range is also sufficient for many types of shrink fit work. Consequently it is desirable to extend the operating temperature range of a chemical refrigerator so that it may be used to treat a larger group of metals, and economically perform a wider variety of functions.

One of the principal objects of the present invention is to provide a cooling device having at least one chamber in which the temperature may be accurately controlled over a wide range of temperatures varying approximately from minus 30° to minus 120° F. Generally it is the concept of this invention to provide a refrigerating device having two cooling chambers. One of the chambers contains Dry Ice immersed in methanol or a similar solvent, and is maintained under a vacuum so that its temperature stabilizes at the lowest temperature required of the apparatus. Generally, the temperature of this chamber may be maintained at a constant value of from minus 130° F. to minus 145° F. This chamber will be termed the primary chamber and may be used for treating those metals which are best treated by direct quenching in an extremely cold bath.

The second chamber preferably contains methanol or some other heat transfer medium with a low freezing point and is kept at atmospheric pressure. It may be desirable, however, in some installations to merely have the second chamber filled with air rather than a liquid. Surrounding each of these chambers is a heat exchange jacket, in the preferred embodiment a coil of tubing. A heat transfer fluid, or coolant is circulated through the jacket surrounding the primary chamber, and then through the jacket surrounding the second chamber. This fluid is cooled by the primary chamber and in turn cools the secondary chamber before it is returned and recirculated through the primary jacket. The temperature of the secondary chamber can be accurately controlled by regulating the rate of coolant flow. For, the more fluid which flows through the system, the more heat which will be removed from the secondary chamber, thus resulting in its being maintained at a lower temperature. In the preferred embodiment, a temperature responsive valve is provided for regulating the rate of coolant flow in response to the temperature of the secondary chamber.

A second object of this invention is to provide a cover for the primary chamber which can be readily removed. With the pressure in this chamber reduced to approximately minus 25 inches, the force required to lift the relatively large lid covering the chamber is very great, amounting to over two tons. This feature of the invention is predicated upon the concept of providing a two-part lid, one part of the lid constituting a cap which fits over a port

in the main lid portion. When removing the lid, the cap which is relatively small is lifted first; this requires only a small fraction of the tremendous force required to lift the entire lid. Then, after the cap has been removed and the vacuum within the chamber relieved, the entire lid may be lifted without any difficulty.

A further feature of the preferred embodiment of my invention is the provision of a mechanical lid positioning assembly. This assembly provides a means for readily moving the lid into a closed position over the cooling chamber or into a storage position in which it is entirely out of the way of anyone filling or emptying the cooling chamber. The lid positioning assembly also provides a means for easily lifting the cap and lid by a partial turn of a handle. The preferred embodiment of the lid positioning assembly includes a vertical post which is pivotally mounted on the top of the cabinet and supports an arm which overhangs the lid. Suspended from the arm is a lifting member which is joined to the cap. A handle and eccentric linkage arrangement are also mounted on the arm in such a way that rotation of the handle reciprocates the lifting member and is thereby effective to raise the cap or force it in sealed engagement with the port. Furthermore, the main lid portion is provided with a lip which overfits the cap so that after the cap has been lifted a small distance free of the port, it engages the lip and the main lid portion may be raised upon further movement of the lifting member by rotation of the handle.

Hence, by means of the lid positioning assembly of the present invention, a lid may be moved from an out of the way position into a position of registry with the top of a cooling chamber. Then, by rotating a handle, it may be lowered against the rim of the chamber and the cap pressed over the port to form a seal for the chamber, which may then be evacuated. When it is desired to remove the contents of the cooling chamber, the handle is rotated in the opposite direction, and during the first portion of its rotation, the cap is disengaged from the port, relieving the vacuum within the chamber. Further rotation of the handle results in the cap engaging the lip of the main lid portion, and the final portion of handle movement results in the main lid portion being lifted entirely free with contact of the rim of the chamber. Thus a single handle movement relieves the vacuum within the lid and also lifts the entire lid, which may then be rotated into an out of the way position while the chamber is loaded and unloaded.

These and other objects and advantages of my invention will be more clearly understood from a consideration of the following detailed description of the drawings.

In the drawings:

Figure 1 is a top plan view of a cooling apparatus constructed in accordance with the present invention.

Figure 2 is a front elevational view of the apparatus shown in Figure 1.

Figure 3 is a side elevational view of the apparatus shown in Figure 1.

Figure 4 is a side view of the lid positioning assembly.

Figure 5 is a top plan view of the lid lifting arm.

Figure 6 is an end view of the lid lifting arm.

Figure 7 is an enlarged partial cross sectional view of the lid showing the cap and port construction.

Figure 8 is a diagrammatic view of the cooling system.

As shown in Figures 1, 2 and 3, the cooling device of the present invention includes a cabinet **10** having a primary chamber **11** and a secondary chamber **12**.

Primary chamber **11** is filled with Dry Ice immersed in methanol or a similar organic solvent such as amyl chloride, propyl ether, or the like. This solution supplies the cooling action for the entire apparatus. A perforated liner **13** is placed in the bottom of cylinder **11**, and an annular space **14** is thus formed between the liner and the wall of cylinder **15**. Primary coils **16** are placed within the annular space and are connected by pipe **17** to a set of coils **18** residing in the annular space formed between cylinder **20** and perforated liner **21** of secondary chamber **12**. Coil **18** is returned through line **22** to reservoir **23** which is, in turn, connected with pump **24**, from which line **25** leads to the primary coil **16**. These coils and their associated piping and pump comprise the coolant system for cooling the secondary chamber **12**.

To evacuate primary chamber **11**, a vacuum pump **26** is provided, although any other suitable means for evacuating the chamber may be employed. Vacuum pump **26** is driven by motor **27** through coupling **28** and includes intake filter **30** (Figures 3 and 8). Suction line **31** of pump **26** is connected to **T 32**. From **T 32**, line **33** leads to gauge **34**, and line **35** communicates with chamber **11**.

To control the temperature in the secondary chamber **12**, a temperature responsive apparatus, indicated at **36** in Figure 8, is connected to a bulb **37** disposed within the secondary tank. The temperature responsive device preferably includes a recording gauge **40** and controls the temperature in chamber **12** by regulating the flow of coolant through the coolant system, including coils **16** and **18**. Control of coolant flow may be exercised in two ways. As shown diagrammatically in Figure 8, the temperature responsive device may control a valve **41** which is effective to channel the output of pump **24** through primary coil **16** and secondary coil **18**, or to recirculate the coolant through line **42** back to reservoir **23** without passing through coils **16** and **18**.

Alternatively, the temperature responsive device could control the operation of motor **43** which drives pump **24** so that the motor is operative only when the temperature in secondary chamber **12** is equal to or above the desired temperature. To alter the temperature maintained in the secondary chamber, it is only necessary to adjust temperature responsive device **36** so that it will actuate valve **41** or motor **43** at different temperatures.

The action of the sublimation of the Dry Ice in the methanol contained in chamber **11** is sufficient to cause an active circulation of the methanol about the parts which are placed within the chamber. However, secondary chamber **12** contains only a coolant and no such action is available to cause circulation. Therefore, in order to more effectively cool the metal parts placed within this chamber, an agitator pump **44**, driven by motor **45**, is provided. This pump is connected to secondary chamber **12**, through pipes **46** and **47**, and effectively circulates the liquid contained in that chamber.

Primary chamber **11** is provided with a lid **48** for sealing the chamber to permit its evacuation. Secondary chamber **12** is provided with a lid **49** which serves only to reduce heat loss from the chamber, since the chamber is not evacuated and therefore does not require an air-tight seal. As best shown in Figures 4 and 7, lid **48** includes a main lid portion **50** having upper and lower plates **51** and **52**. These plates are separated by ring **53** providing an insulating air space **54** within the lid. The lid is provided with a central port **55** in which bushing **56**, constructed of an insulating material, such as formica, is inserted. Bushing **56** includes a flange **57** which compresses gasket **58** against lower plate **52** to provide an air-tight seal between port wall **59** and bushing **56**. Bearing ring **60** overfits the top of bushing **56** and may be cemented or otherwise secured to the bushing to hold it in place within the port. A lip member **61** is secured by means of bolts **62** to ring **63**, disposed on the inside of the upper plate **51**. Lip **61** is configurated to form vent holes **64** and has a central opening **65** which accommodates part of cap **66**.

The function of cap **66** is to close port **55** when the primary chamber is evacuated. When removing the lid, cap **66** is first lifted from the port to release the vacuum within the chamber before the main lid portion **48** is lifted. Cap **66** is fitted with a sealing gasket **67** which resides in an annular groove in the cap and is disposed for engagement with bearing ring **60**. An inverted cup

68 or similar means such as fingers, is welded to the top of cap 66 and is provided with an opening 69 for receiving rod 70 which includes a head 71 or other enlargement at its end. Rod 70 is threaded into tube 72 and together with pin 73 they constitute lifting member 74.

The lid positioning assembly 75, of which the lid lifting member 74 is one component, includes a vertically disposed rotatable post 76. Arm 77 extends horizontally outwardly from the post over the lid 48. Arm 77 is of generally rectangular cross section and is welded or otherwise secured to post 76. A boss 79 is provided on the lower edge of the arm for guiding lifting member 74. A fillet plate 78 and stiffening ribs 80 strengthen the arm. The arm carries an eccentric lever arrangement 81 including link 82 which is hingedly connected to the arm as at 83. The other end of link 82 is provided with a groove 84 for slidably receiving pin 85 of eccentric plate 86. Plate 86 is rigidly mounted upon shaft 87 which is journaled in block 88, secured to arm 77. Shaft 87 can be rotated by handle 90 which is joined thereto, rotation of the handle being limited by stops 91 and 92 which are secured to arm 77. Link 82 is provided with a second longitudinal slot 93 which accommodates pin 73 of lifting member 74, link 82 fitting in recessed porton 95 of tube 72.

When operating the chilling apparatus, methanol and Dry Ice are placed in primary chamber 11. Arm 77 is then rotated so that lid 48 covers the top of the primary chamber. The handle 90 is then rotated in a clockwise direction rotating eccentric plate 86 in the same direction so that pin 85 forces link 82 downwardly. Link 82 contacts pin 73 forcing the lifting member downwardly. The lifting member in turn urges cap 66 against bearing ring 60 to seal port 55. Vacuum pump 26 is then started to draw a vacuum on chamber 11. Also if the secondary chamber is to be used, the desired temperature is set on the temperature control device, and pump 24 is started to circulate the coolant through the primary and secondary jackets.

After the temperature of the primary chamber is stabilized handle 90 is rotated counterclockwise rotating eccentric plate 86 so that pin 85 forces link 82 upwardly causing lifting member 74 to engage cup 68, thereby raising cap 66. This opens port 55 and releases the vacuum within the primary chamber. Further counterclockwise rotation of the handle causes lifting member 74 to be raised an additional amount, whereupon cap 66 engages lip 61 raising the entire lid. The lid may then be rotated into the storage position by turning post 76. After the primary chamber has been filled with the material to be chilled, the lid is again placed over the chamber and the vacuum restored.

The secondary chamber may be used as soon as its temperature has stabilized, which will normally occur prior to the stabilization of the primary chamber temperature. The control over the temperature of the secondary chamber is exercised by temperature control device 36 which, by governing the circulation of coolant through valve 41 or pump 24, regulates the temperature of the secondary chamber accurately irrespective of the temperature of the primary chamber.

It will be noted that in the embodiment shown, coils 16 and 18 of the coolant system are completely immersed in the liquids contained in the primary and secondary cooling chambers. Thus, the heat losses involved in cooling the secondary chamber by means of a circulating coolant fluid are minimized, and furthermore the coolant fluid is maintained at the lowest possible temperature thereby minimizing the time required to lower the temperature of the secondary chamber and in fact permitting its temperature to stabilize before the primary chamber reaches its equilibrium temperature.

While this invention has been disclosed principally in connection with a device for chilling metals, it will be obvious that its utility is not limited solely to this application. Rather, the cooling device disclosed herein may be employed advantageously in any field where it is desired to maintain an air or liquid filled chamber at a low temperature, the exact value of which may be selected from a wide range, and then may be accurately maintained.

Having described our invention, we claim:

1. A lid for sealing the top of a vacuum cooling chamber, and a lid positioning assembly, said lid being constituted by a main lid portion adapted for engagement with the top of said chamber and being configurated to have a port therein, a cap disposed above said port and being adapted for vertical movement into and out of sealed engagement with said port, and a lip secured to said main lid portion and disposed to engage said cap upon upward vertical movement, thereof, said lid positioning assembly comprising an arm extending horizontally over said lid, a lifting member in cooperative engagement with said cap, means carried by said arm for reciprocally moving said lifting member vertically, whereby upon upward movement of said member said cap is initially disengaged from said port releasing the vacuum within said chamber, and upon further movement of said lifting member, the cap is brought into engagement with said lip, whereupon still further movement of the lifting member results in the main lid portion being raised.

2. A lid for sealing the top of a vacuum cooling chamber, a lid positioning assembly, said lid being constituted by a main lid portion adapted for engagement with the top of said chamber and being configurated to have a central port therein, a cap disposed above said port and being adapted for vertical movement into and out of sealed engagement with said port, and a lip secured to said main lid portion and disposed to engage said cap upon upward vertical movement thereof, said lid positioning assembly comprising an arm extending horizontally over said lid, a lifting member depending from said arm and in cooperative engagement with said cap, an eccentric lever arrangement carried by said arm for reciprocally moving said lifting member vertically whereby upon upward movement of said member said cap is initially disengaged from said port releasing the vacuum within said chamber and upon further movement of said lifting member the cap is brought into engagement with said lip whereby upon further upward movement of said lifting member the main lid portion is raised.

3. A lid for sealing the top of a vacuum cooling chamber mounted within a cabinet, a lid positioning assembly for moving said lid into a storage position or into a position in which it seals said cooling chamber, said lid being constituted by a main lid portion adapted for engagement with the top of said chamber and being configurated to have a central port therein, a cap disposed above said port and being adapted for vertical movement into and out of sealed engagement with said port, and a lip secured to said main lid portion and disposed for engagement with said cap upon upward movement thereof, said lid positioning assembly comprising a vertical post rotatably supported by said cabinet, an arm mounted upon said post and extending horizontally over said lid, a lifting member in cooperative engagement with said cap, means carried by said arm for reciprocally moving said lifting member vertically, said means being actuated by a handle in such a manner that initial rotation of said handle results in upward movement of said lifting member and said cap releasing the vacuum within said chamber, and further movement of said handle results in the lid portion being raised.

4. A lid for sealing the top of a vacuum cooling chamber, a lid positioning assembly for moving said lid into a storage position or into a position in which it seals said cooling chamber, said lid being constituted by a main lid portion adapted for engagement with the top of said chamber and being configurated to have a central port

therein, a cap disposed above said port and being adapted for vertical movement into and out of sealed engagement with said port, and a lip secured to said main lid portion and disposed for engagement with said cap upon upward movement thereof, said lid positioning assembly comprising a vertical post, an arm mounted upon said post and extending horizontally over said lid, a lifting member in cooperative engagement with said cap, means carried by said arm for reciprocally moving said lifting member vertically, said means including a lever hingedly mounted upon said arm, said lever being configurated to form a first slot and a second slot therein, a shaft, an eccentric block mounted upon said shaft, said block carrying a pin, said pin engaging said first slot in said lever, said lifting member having a removed portion to accommodate said lever and a pin disposed within said second slot in said lever, a handle secured to said shaft whereby rotation

of said handle causes said lever to rotate raising said lifting member and said cap and further rotation of said handle causes said main portion of the lid to be lifted.

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